DESIGN OF A SEWERAGE SYSTEM
SOUTH RANGE, MICHIGAN

BY

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ARMOUR INSTITUTE OF TECHNOLOGY

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DESIGN

# of a

SEWERAGE SYSTEM.

SOUTH RANGE, MICHIGAN.

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A Thesis Presented By

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To The

PRESIDENT AND FACULTY

Of

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For the Degree of

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Alfred E. Phillips - Prof Civil Engineering
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L. C. Monin, Dean Cult. Studies.

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The notes for this sewerage system were taken in 1907. They were obtained from the Engineer in charge for the purpose of this thesis.

The combined system of sewerage was adopted and the sewers designed for the maximum rainfall since the house sewage was small in amount. The rainfall used was three inches in twenty-four hours and two-thirds of this was assumed to pass into the sewers. Although the town is one-quarter section in area, an area of three-quarter sections was drained. This area was obtained from the study of a large topographic map, a quarter section each being drained by two well defined creeks which passed through the town. One of these creeks enters at the north west of the town, and the other at the south-west.

From the topographic map of South Range it is seen that the lowest part of the town is in the south-east corner. From here the ground slopes to a river and this place was therefore decided upon as the outlet. A trunk sewer was then placed north on Atlantic Avenue, the eastern limits of the town, to 5th Street. A lateral was then placed along 5th Street to Globe Avenue and from Globe Avenue to the first alley north. This large lateral is for the purpose of intercepting the creek which enters at the north-western part of the

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town. At some future date this sewer will have to be continued west up this alley and then south through a lot, and a large catch-basin built in 5th Street in order to drain the creek.

The second large lateral was run up Trimountain Avenue to Globe Avenue, and then south on Globe Avenue to Stanton Avenue where a large catch-basin was located so as to drain the creek entering at the south-west corner of the town. The rest of the laterals were designed to drain their respective areas.

In designing the formula $v = c\sqrt{rs}$ was used for the velocity, s being the slope, r the hydraulic radius and c the value obtained from Kutter's formula:

$$C = \frac{\frac{1.811}{n} + 41.65 + \frac{0.00281}{s}}{1 + \frac{n}{\sqrt{r}} \left\{ 41.65 + \frac{0.00281}{s} \right\}}$$

n was taken at .015

The assumed cross section was then checked from the formula $a = \frac{q}{v}$ where q is the discharge per second in cubic feet and v is the velocity above.

Design for Outlet Sewer.

Assume a 3-1/2 ft. brick sewer.

Cross sectional area = 9.621 sq.ft.

Hydraulic radius (r) = .875 ft.

$$c = \frac{\frac{1.811}{.015} + 41.65 + \frac{0.00281}{.0024}}{1 + \frac{.015}{.935}\left(41.65 + \frac{0.00281}{.0024}\right)}$$

$= 97.1$

$v = c\sqrt{rs} = 97.1 \times .935 \times .049 = 4.45$ ft. sec.

q for three quarter section or 120 acres = 40.3 cubic feet per second.

$a = \frac{q}{v} = \frac{40.3}{4.45} = 9.05$ sq.ft. which is less than the assumed section and may therefore be used.

PROPOSAL.

In the bidding on the following sewers and appurtenances, the slants and junctions to the number given below, shall be included in the bid per lineal foot of sewer.

To the President and Board of Trustees of the Village of South Range, Michigan;-

Gentlemen:-

The undersigned hereby propose to do the following work for the prices set opposite each item below:

Atlantic Avenue from south limits to 6th Street:

Stanton Avenue to 3rd Street:-

1140 ft. of 3-1/2 ft. brick sewer, average cut 9 ft. at ...... per ft.

3rd Street to 5th Street:-

550 ft. of 3 ft. brick sewer, average cut 8.4 ft. at .... per ft.

5th Street to 6th Street:-

550 ft. of 10 in. pipe, average cut 7.6 ft. at .... per ft.

4 - 15 in. slants.

1 - 12 in. slants.

14 Manholes with iron covers at .... per Manhole.

15 Catch-basins with iron covers and connection at .... per catch-basin.

Stanton Avenue from east limits to 531 ft. west of Champion Avenue and from Globe Avenue to West limits:

Atlantic Avenue to 177 ft. west of Baltic Avenue:-

900 ft. of 12 in. pipe, average cut 6.2 ft. at .... per ft.

177 ft. west of Baltic Avenue to 527 ft. west of Baltic Avenue:-

350 ft. of 10 in. pipe, average cut 7 ft. at ...... per ft.

527 ft. west of Baltic Avenue to 531 ft. west of Champion Avenue:-

676 ft. of 8 in. pipe, average cut 6.8 ft. at ...... per ft.

Globe Avenue to 145 ft. west of Globe Avenue:-

125 ft. of 2 ft. brick sewer, average cut 12 ft. at .... per ft.

145 ft. west of Globe Avenue to Whealkate Avenue:-

545 ft. of 8 in. pipe, average cut 9 ft. at .... per ft.

19 Manholes with iron covers at ...... per Manhole.

8 Catch-basins with iron covers and connections at .... per catch-basin.

1 large catch-basin with iron cover and connections at ..... per catch-basin.

15 - 6 in. by 12 in. junctions.

5 - 6 " " 10 " "

14 - 6 " " 8 " "

Trimountain Avenue from east limits to west limits:

Atlantic Avenue to Baltic Avenue:-

695 ft. of 2-1/2 ft. brick sewer, average cut 11.4 ft. at ...... per ft.

Baltic Avenue to Globe Avenue:-

1330 ft. of 2 ft. brick sewer, average cut 12.3 ft. at .... per ft.

Globe Avenue to Whealkate Avenue:-

728 ft. of 8 in. pipe, average cut 12.8 ft. at .... per ft.

18 Manholes with iron covers at ...... per Manhole.

16 Catch-basins with iron covers and connections at .... per Catch-basin.

67 - 6 in. slants.

24 - 6 in. by 8 in. junctions.

1st. Street from east limits to west limits:-

Atlantic Avenue to Baltic Avenue:-

600 ft. of 15 in. pipe, average cut 6.0 ft. at .... per ft.

Baltic Avenue to Champion Avenue:-

710 ft. of 12 in. pipe, average cut 6 ft. at .... per ft.

Champion Avenue to Globe Avenue:-

660 ft. of 10 in. pipe, average cut 11.1 ft. at ...... per ft.

Globe Avenue to Whealkate Avenue:-

722 ft. of 8 in. pipe, averahe cut 6.9 ft. at .... per ft.

19 Manholes with iron covers at .... per Manhole.

16 Catch-basins with iron covers and connections at .... per Catch-basin.

18 - 6 in. by 15 in. junctions.
17 - 6 in. by 12 in. "
23 - 6 in. by 10 in. "
26 - 6 in. by 8 in. "

2nd. Street from east limits to west limits:

Atlantic Avenue to Baltic Avenue:-

608 ft. of 15 in. pipe, average cut 7.6 ft. at .... per ft.

Baltic Avenue to Champion Avenue:

710 ft. of 12 in. pipe, average cut 5.8 ft. at .... per ft.

Champion Avenue to Globe Avenue:-

660 ft. of 10 in. pipe, average cut 6.9 ft. at .... per ft.

Globe Avenue to Whealkate Avenue:

750 ft. of 8 in. pipe, average cut 9.0 ft. at .... per ft.

17 Manholes with iron covers at .... per Manhole.

16 Catch-basins with iron covers and connections at .... per Catch-basin.

16 - 6 in. by 15 in. Junctions.

20 - 6 in. " 12 in. "

19 - 6 in. " 10 in. "

27 - 6 in. " 8 in. "

3rd. Street from east limits to west limits:

Atlantic Avenue to Baltic Avenue:-

584 ft. of 15 in. pipe, average cut 7.2 ft. at .... per ft.

Baltic Avenue to Champion Avenue:-

710 ft. of 12 in. pipe, average cut 6 ft. at .... per ft.

Champion Avenue to Globe Avenue:-

660 ft. of 10 in. pipe, average cut 6.8 ft. at .... per ft.

Globe Avenue to Whealkate Avenue:-

770 ft. of 8 in. pipe, average cut 7.5 at .... per ft.

19 Manholes with iron covers at .... per Manhole.

16 Catch-basins with iron covers and connections at .... per Catch-basin.

16 - 6 in. by 15 in. Junctions.

20 - 6 in. by 12 in. "

19 - 6 in. by 10 in. "

28 - 6 in. by 8 in. "

4th. Street from east limits to west limits:

Atlantic Avenue to Baltic Avenue:-

560 ft. of 15 in. pipe, average cut 7.6 ft. at .... per ft.

Baltic Avenue to 281 ft. west of Champion Avenue:-

991 ft. of 12 in. pipe, average cut 7 ft. at .... per ft.

281 ft. west of Champion Avenue to Globe Avenue:-

380 ft. of 10 in. pipe, average cut 6.8 ft. at .... per ft.

Globe Avenue to 620 ft. west of Globe Avenue:-

620 ft. of 8 in. pipe, average cut 6.8 ft. at .... per ft.

18 Manholes with iron covers at .... per Manhole.

16 Catch-basins with iron covers and connections at .... per Catch-basin.

14 - 6 in. by 15 in. Junctions.

20 - 6 in. by 12 in. "

21 - 6 in. by 10 in. "

29 - 6 in. by 8 in. "

5th. Street from east limits to 345 ft. west of Globe Avenue:

Atlantic Avenue to Baltic Avenue:-

535 ft. of 2-1/2 ft. brick sewer, average cut 7.2 ft. at .... per ft.

Baltic Avenue to Globe Avenue:

1365 ft. of 2 ft. brick sewer, average cut 8.9 ft. at .... per ft.

Globe Avenue to 330 ft. west of Globe Avenue:

330 ft. of 8 in. pipe, average cut 8.5 ft. at .... per ft.

15 Manholes with iron covers at .... per Manhole.

14 Catch-basins with iron covers and connections at .... per Catch-basin.

1 - 18 in. slant.

56 - 6 in. slants.

12 - 6 in. by 8 in. Junctions.

6th. Street from Atlantic Avenue to 360 ft. west of Atlantic Avenue and from Baltic Avenue to 119 ft. west of Globe Avenue:

Atlantic Avenue to 360 ft. west of Atlantic Avenue:-

360 ft. of 8 in. pipe, average cut 6.4 ft. at .... per ft.

Baltic Avenue to Champion Avenue:-

670 ft. of 12 in. pipe, average cut 6.8 ft. at .... per ft.

Champion Avenue to 119 ft. west of Globe Avenue:-

779 ft. of 10 in. pipe, average cut 6.8 ft. at .... per ft.

13 Manholes with iron covers at .... per Manhole.

12 Catch-basins with iron covers and connections at .... per Catch-basin.

12 - 6 in. by 8 in. Junctions.

20 - 6 in. by 12 in. "

27 - 6 in. by 10 in. "

7th. Street from Baltic Avenue to 390 ft. east of Baltic Avenue and from Baltic Avenue to West limits:

Baltic Avenue to 390 ft. east of Baltic Avenue:-

390 ft. of 8 in. pipe, average cut 6.8 ft. at .... per ft.

Baltic Avenue to Champion Avenue:-

670 ft. of 15 in. pipe, average cut 6.8 ft. at .... per ft.

Champion Avenue to 290 ft. west of Globe Avenue:-

950 ft. of 12 in. pipe, average cut 7 ft. at .... per ft.

290 ft. west of Globe Avenue to Whealkate Avenue:-

574 ft. of 8 in. pipe, average cut 7.7 ft. at .... per ft.

18 Manholes with iron covers at .... per Manhole.

8 Catch-basins with iron covers and connections at .... per Catch-basin.

16 - 6 in. by 8 in. Junctions.

10 - 6 in. by 15 in. "

16 - 6 in. by 12 in. "

Baltic Avenue:

1st. Street to 100 ft. south of 1st Street:-

100 ft. of 8 in. pipe, average cut 5.4 ft. at .... per ft.

2nd. Street to 200 ft. south of 2nd Street:-

200 ft. of 8 in: pipe, average cut 6.4 ft. at .... per ft.

3rd. Street to 200 ft. south of 3rd Street:-

200 ft. of 8 in. pipe, average cut 7 ft. at .... per ft.

4th. Street to 200 ft. south of 4th Street:-

200 ft. of 8 in. pipe, average cut 6.9 ft. at .... per ft.

5th. Street to 200 ft. south of 5th Street:-

200 ft. of 8 in. pipe, average cut 7.2 ft. at .... per ft.

5th. Street to 7th Street:-

552 ft. of 18 in. pipe, average cut 7.6 ft. at .... per ft.

36 - 6 in. by 8 in. Junctions.

16 - 6 in. by 18 in. "

Globe Avenue from Trimountain Avenue to Stanton Avenue:-

289 ft. of 2 ft. brick sewer average cut 10.8 ft. at .... per ft.

2 Manholes with iron covers at .... per Manhole.

1 - 8 in. slant.

2 - 6 in. by 8 in. Junctions.

Globe Avenue from 5th Street to 1st alley north:-

146 ft. of 2 ft. brick sewer, average cut 9 ft. at .... per ft.

SPECIFICATIONS.

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PLANS.

The Plans and Drawings showing location and dimensions of sewers to be constructed, prepared by the Engineer, and on file in the office of the Village Clerk with all notes, dimensions, figures and corrections thereon, shall be considered a part of these Specifications, and in event of any discrepancy between plans and specifications, the judgment of the Board of Trustees or its authorized Engineer shall be decisive thereon.

BIDS.

The Contractor shall, for the price bid per lineal foot for the sewer proper, do all the work prescribed in these specifications, including foundations and all necessary work and material for building of outfall, make the requisite excavation for building the sewers and their appertaining structures and connections, shall do all the ditching, diking, pumping, bailing and draining, all sheeting and shoring; shall make all provisions necessary to maintain and protect all buildings, walls, fences, trees, gas pipe, water pipe, conduits, sewers, railings, electric and cable lines, and other structures, and shall repair all damages occurring to

same during the progress of the work, shall provide all bridges, fences or other means of maintaining travel on intercepted streets, roads and railroads, and on streets or roads in which the trenches are excavated, after giving due notice to parties effected thereby; shall maintain the same in good and safe condition so long as may be necessary; and then shall remove such temporary expedients and restore such ways to their proper condition; shall provide watchmen, fences, red lights and all other precautionary measures necessary to the protection of person and property; shall provide all centers and forms; shall construct all foundations, all brick, concrete and timber work; shall set in place all iron work, and refill all trenches; shall furnish all material and all tools, implements and transportation required to build and put in complete working order the sewer or sewers awarded him, and shall do each and all to the satisfaction of the Board of Trustees, The prices bid are to include the cost of timbering all railroad tracks, the removal, and the delay or damge occasioned by trees, roots, timber or masonry structuresor other obstacles, whether shown on plan or not.

EXCAVATION.

The ground shall be excavated in open trenches,

in such direction as required, to the width and depth as may be necessary for the proper construction of the sewers according to plan.

Trenches must be sheeted where necessary and provision made to keep the sewers dry during their construction. The trenches must be of sufficient width to admit of ample room within the lines of the sheeting to permit of the work being constructed in the manner and size specified. Wherever the nature of the ground will admit of it, the bottom of the excavation is to have the shape and dimensions of the outside of the lower half of the sewer. In order to secure this, the Contractor is to provide a pattern or form made with two segments one to fit the outside and the other the inside of the invert. It is to be firmly and securely set to the proper grade, by the stake given by the Engineer, and is to remain unmoved in its position until after the masonry is laid. The bed for the sewers is then to be brought to the required shape, by trimming, with suitable tools, to a line stretched from the outside of the masonry to the form.

All surplus material excavated, not required for back-filling, must be disposed of by the Contractor at his own expense, The sidewalks must in no case be obstructed, and the Contractor shall make provision at all

cross streets for the free passage of vehicles and foot passengers, either by bridging or otherwise.

All water, gas or other kinds of pipes are to be carefully supported and protected from injury by the Contractor, either until the sewer is built and the backfilling finished, or, if it is necessary until the proper officer shall remove or change them.

When existing sewers have to be taken up or removed the Contractor must provide and maintain temporary outlets and connections for all private or public drains or sewers, and he must take care of all sewage and storm water which will be received from these drains and sewers, and discharge the same; and for this purpose he must provide and maintain, at his own expense, an efficient pumping plant, and be prepared at all times to dispose of the water and sewage received from these temporary connections until such times as the permanent connections with the new sewers are built and in service.

All paving, graveling, macadamizing, planking, sidewalks, culverts and crosswalks, or any street paving or walks whatever, are to be carefully removed before the excavation is made, and kept separate from other excavated material, and replaced after sewer is completed.

When rock is encountered in excavating the trenches it is to be removed by drilling and blasting, or otherwise, as directed by the Engineer, to the surface of the outside

of the bottom of the sewer. Whenever a main water or gas pipe crosses the line of the trench, the rock on each side of the pipe, for the distance of five feet, is to be removed without blasting.

Where blasts are made the trench is to be carefully covered with suitable brush or timber to prevent danger to life and property.

Before the sewer is built all irregularities of the rock are to be filled with sand and gravel, well rammed into its place

SHEETING AND BRACING.

The Contractor must furnish and put in place at his own expense such shores, braces, sheeting, etc., as may be considered necessary by the Engineer for the safety of the work or the public, and no sheeting shall be used less than two (2) inches in thickness.

The sheeting and bracing shall be removed as the work progresses, in such a manner as to prevent the caving in of the sides of the excavation, and, while being drawn, all vacancies left by the plank shall be carefully filled by ramming, with special tools, or by puddling as the Engineer may direct.

The Engineer may order the sheeting and bracing left in, when in his opinion it is necessary for the protection of the work; in such cases only will a charge be al-

lowed for the same.

The Contractor shall at his own expense shore up and restore and make good, as may be necessary, all fences, buildings, walls, conduits, railroad tracks or other properties which may be disturbed during the progress of the work, and the said Contractor will be held responsible for all damages which may happen to neighboring properties, or in any other way from neglect of this precaution.

FOUNDATIONS.

Whenever the ground is sufficiently firm and unyielding the masonry or pipes are to be laid directly on the bottom of the excavation; but whenever this shall not be the case, it shall be built of masonry, concrete, or of pine plank and timber, as the Engineer may direct.

The Contractor will be allowed extra compensation for this work at a price to be agreed upon for the different kinds of foundation required.

PROTECTION AGAINST WATER.

The Contractor is to do all pumping and bailing, to build all drains and to do all other work necessary to keep the trench and sewer clear of ground water, sewage or storm water during the progress of the work, and until the cement mortar is sufficiently set to be safe from injury.

To this end, in wet trenches he is to keep a channel open on each side of the work during its construction, which shall be so maintained as to catch the water from the sides of the trench and to conduct it to a sufficient pump or bail hole in front of the work.

BACK-FILLING.

After the arching is completed on any length of sewer, and before the centers are struck, the trench is to be filled to a height of not less than two feet above the arch, on brick sewers the spandrels are to be well consolidated to a height of six inches above the crown of the arch, by thorough ramming wherever the ground is of a nature to admit it. As soon as the mortar and masonry are sufficiently set, the trench is to be sufficiently filled to prevent liability of injury to the banks, road surfaces, adjacent pipes, railroad tracks, sidewalks or other property, public or private.

The surplus material taken from the trench is to be removed entirely from the street, or disposed of in such a manner as directed, so as to save the Village from all damages or expense on account thereof.

The back-filling shall in all cases be left with a smooth and even surface. Where required the back-filling shall not be left unfinished more than 200 feet behind the completed masonry or pipe work.

CENTERING AND PATTERNS.

The centering patterns and templets necessary in the construction of the work are to be furnished by the Contractor at his own expense.

The centers upon which the arch is formed must be strong and made accurately, and shall in no case be used until approved by the Engineer.

MASONRY.

The brick sewer two and one-half (2-1/2) feet in internal diameter is to be built of two shells or rings of bricks:

The bricks must be clean and thoroughly wet before being laid; the most perfectly formed bricks and those with the smoothest surfaces are to be used in the inside courses of the sewer, the smoothest edge of the brick being laid to the face.

The courses are to be laid to line, and kept perfectly straight in the direction of the sewer, and parallel to the rise of the same," and shall be laid as stretchers, breaking joints with those in the adjacent courses.

Every brick must be separately laid in full mortar joints on bottom, side and end, which for each brick must be formed by one operation.

In no case is the joint to be made by grouting, or

by working in mortar after laying the brick.

No joint shall exceed one-half (1/2) of an inch in thickness, and all joints on face shall be trowel-struck.

All brick work as it progresses must be racked back in courses, and in no case will it be allowed to be toothed, except by permission of the Engineer.

The mortar joints on the inside of the sewers, below the center line are to be carefully struck when laid, and those above to be scraped smooth with the bricks immediately after the centers are struck. The refuse mortar is to be scraped off and removed entirely from the sewer before it has time to harden.

All inverts or bottom courses are to be worked from templets, accurately made, and correctly set to the lines and grades furnished.

DEAD END OF SEWERS.

The end of all sewers, pipes and junctions, when not immediately used, must be securely closed with brick masonry, or stone covers.

MANHOLES.

All manholes are to be circular in section and three feet internal diameter. They are to be built with two rings of brick, giving a thickness of eight inches to

the wall. The bricks in the inside ring are to be set vertically. The outer ring is to be built of bats as far as broken bricks on hand will go, otherwise whole bricks are to be used, set as in the inside ring, and breaking joints therewith.

The top course of bricks in each manhole is in all cases to be made of whole brick, laid as headers. The tops are to be two feet in diameter, being drawn in by means of six header courses laid horizontally, the diameter being decreased two inches for each course.

On sewers less than three feet in diameter, the manholes are to have solid foundations of brick or concrete laid twelve inches below the grade of the sewer.

CATCH-BASINS.

All catch-basins shall be three and one-half (3-1/2) feet inside diameter, built of two rings of brick set as specified for manholes, upon a floor of six (6) inches of concrete, to be trapped with a brick trap and connected to the sewer with eight (8) inch pipe. The brick work shall be five feet six inches (5'6") deep. The bottom of the outlet pipe to be set three (3) feet above the bottom of the brick work, and the iron rail for the brick trap shall be set two and one-half (2-1/2) feet above the bottom. The top of the cover to be set eight inches below the grade of

the street, and when directed, the Contractor shall leave an inlet to the basin under the cover, to receive the water from the ditches, eight (8) inches in diameter.

COVERS.

All covers used shall be of good quality of cast iron. A curb and lid shall weigh not less than Three Hundred Fifty (350) pounds, and shall be the size and pattern directed by the Engineer.

PIPE LAYING.

Each pipe is to be laid on a firm bed, and in perfect conformity with the line and levels given. The joints of the pipe are to be as uniform as possible and thoroughly filled with mortar. Each joint is to be wiped clean of mortar on the inside before another length of pipe is laid.

SIDE JUNCTIONS.

Intersections or entrances for lateral sewers, whether of brick or pipe, and all junctions for street drains are to be built into the sewers at such places as shown on plans, six-inch junctions for house drains to commence ten feet from street corners and to be placed thence twenty-five (25) feet apart, through the blocks, in a thorough and workmanlike manner. The junctions are to be bricked off at the ends, thoroughly closing them against sand or other material, or

closed with suitable stone covers. The pipe junctions are to be closed by laying the brick against the end of the pipe. In no case are the bricks to be placed inside the pipe.

OUTLET.

The outlet for the main sewer is to be built as follows: A concrete foundation at least one foot in thickness shall be built with its bottom one foot and nine inches (1'9") below the bottom of the inside of the sewer or so much below said bottom as is necessary in order to reach solid ground, and said concrete shall measure three feet eight inches (3'8") in the direction of the sewer and be seven (7) feet wide: Upon this foundation shall be placed brick masonry, measuring three feet four inches (3'4") in the direction of the sewer, and shall taper to 18 inches at the top, which is 5 feet (5) above said concrete foundation, and the width of said masonry shall be seven (7) feet. Concrete shall be placed on the top of the masonry measuring 18 inches by seven (7) feet by four (4) inches thick. The Contractor shall be paid at the rate of eight dollars per cubic yard, for extra concrete used including excavation for any depth it may be found necessary to excavate below the point one foot and nine inches (1'9") below the bottom of the inside of the sewer at the outlet.

MATERIALS.

All materials, of whatever nature, required in the

construction of the sewers, catch-basins and manholes, shall be new and of the best quality, and shall be furnished by the Contractor, except such lumber as is herein mentioned.

BRICKS.

The bricks shall be the best quality for the purpose for which they are intended, uniform in quality, sound and hard burned, free from lime and cracks, and to have a clear, ringing sound when struck, whole and with edges full and square, and of standard dimensions, viz: 8 x 4 x 2-1/4 inches; they shall be of compact texture, and after being thoroughly dried and immersed in water for twenty-four hours shall not absorb more than 10 per cent in weight of water.

PIPE.

The pipe shall be straight, smooth and sound, thoroughly burned and vitrified, well glazed, free from lumps or other imperfections, and with the least possible variation from the specified dimensions or true cylindrical shape. All straight pipe must be straight in the direction of the axis of the cyliner, and the inner and outer surface of each pipe must be concentric. The standard of thickness shall be; for 15 inch. pipe, 1-1/8 inches; for 12 inch pipe, 1 inch; and for 8 inch pipe 7/8 inch, with a limit of variations not exceeding 1/8 of an inch either way, all to

be made with butt joints, square, and at right angles with the axis of the pipe. The curves, slants and Y junctions must conform to all the foregoing requirements as regards quality, form and workmanship, and the thickness shall be equal to that of pipes of the same caliber into which they may be worked or jointed. All slant junctions and branch junctions to be molded for an angle of thirty-four (34) degrees with the sewer with which they are to connect.

CEMENT.

The cement shall be of some satisfactory and reliable brand of American Portland Cement and of such quality and uniformity as has been demonstrated to be of superior quality and thoroughly adapted to the construction of sewers and similar work, and shall be approved by the Engineer.

The cement shall be American Portland cement of reputation known and established by use. It shall be ground so that ninety-three (93) per cent. will pass a standard sieve of ten thousand (10,000) holes per square inch, and mixed one (1) part cement and three (3) parts sand shall show a tensile strength of one hundred and sixty-five (165) pounds per square inch in seven days--one (1) day in air and six (6) days in water-and an increase of not less than 33 per cent. in strength at the end of twenty-eight (28) days, and an additional increase of 15 per cent. at the end of three (3) months.

The Contractor shall submit sampbes of the cement he desires to use, and three (3) to five (5) brands may be approved by the Engineer, any of which the Contractor may use.

INSPECTION OF MATERIALS.

All materials, of whatever nature, will be inspacted upon the ground when delivered, by an Inspector, who shall upon finding defective or poor material of any kind, immediately report same to Engineer in charge of the work, and the Contractor shall, when notified by said Engineer, at once remove said defective or poor material from line of work.

MORTAR.

The mortar shall be made by careful measuring and thoroughly incorporating one part of cement with three parts of clean, sharp sand in dry state, and mixed with clean water to the proper consistency, and shall ne used while fresh, and the use of mortar which has been set and then retampered will not be allowed. The mortar used in laying pipe sewers shall consist of one part of cement, and one part of sharp find sand as above specified, all to be furnished by the Contractor without extra charge.

CONCRETE.

All concrete shall be composed of one (1) part ce-

ment, three (3) parts clean stamp sand, and seven (7) parts of broken stone, stone to be of good quality, graduated in size, angular in shape, and free from dirt or clay. All stone must be broken, so that the largest side shall not exceed one and one-half (1-1/2) inches. The cement and sand shall be measured and shall be thoroughly mixed, dry, until of a uniform color, and shall be wet with as little water as will render it proper for use, and thoroughly worked. The stone shall be measured and spread about four (4) inches thick on a tight board platform. The mortar shall be spread evenly on the stone, and the whole shall be turned in place with shovels without heaping until each stone is thoroughly coated with mortar. The stone shall be wet if required, before the mortar is spread.

SPECIAL AND GENERAL REQUIREMENTS.

The Contractor shall employ capable superintendents or foremen to represent him on the work and they shall receive and obey orders from the Engineer.

He shall also employ a sufficient number of competent men, and furnish all the material necessary to carry on the work with dispatch.

If at any time in the opinion of the Engineer the work is not progressing satisfactorily he may direct the Contractor to employ more men, and should he fail to do so,

after reasonable notice, the Engineer may then, by and with the consent of the Board of Trustees, employ additional help and furnish such additional material as is, in its judgment, necessary for the completion of the contract in the time specified, and deduct the expense thus incurred from any money due the Contractor.

The sewers after completion, must be left entirely clear of rubbish and dirt of every kind and description; the dead ends are to be carefully closed with brick masonry or stone covers so as to exclude all running sand or other material.

The Contractor shall furnish all necessary facilities, should it be deemed advisable by the Engineer, to make an examination of any work already completed. If the work is found defective in any respect, the Contractor shall defray the expense of such examination and of satisfactory reconstruction. If the work is perfect, such expense will be allowed for.

No extra or customary measurements of any kind will be allowed in measuring the work under these Specifications; but the actual length, area, solid contents, or number shall be considered, and the length shall be measured on the center line of the work whether straight or curved.

No work in masonry shall be done when the thermometer is below thirty-five (35) degrees F., without written

permission from the Engineer, and then under conditions for protecting it from frost approved by him.

The Contractor shall execute the work only in the presence of the Engineer or Inspector during the working hours of the day, unless otherwise directed by the Engineer; but the presence or superintendence of the said Engineer or Inspector shall in no way relieve him of the responsibility of his work, or be any warrant for him to furnish bad material or poor workmanship.

The Contractor will be required to guard the public effectually from liability to accident in consequence of his operation during the whole progress of the work, both by night and by day, and will be held responsible for any damages that the Village may have to pay in consequence of neglect on the part of the Contractor to protect the public against such accidents.

The Contractor will also be held responsible for all damages said Village may have to pay to private individuals or corporations in consequence of any of the acts or doing or neglect of said Contractor, or any of his employes, in connection with said work. In addition to the necessary barriers, a red light must be maintained at night, at each end of the trench.

The Contractor will be required to dig all stake holes and furnish the stakes necessary to give the lines and levels for the work in time for the visit of the Engineer in charge at such time as he may appoint. All railroads not required to be taken up, must be kept in constant running order, and they must be left after the completion of the work in as good condition as they were in before its commencement by the Contractor. No allowance will be made for delays or other damages occasioned by the necessity of keeping the railroads in constant running order, or for removing or replacing the same when it is necessary to do so.

No claim for extra labor or materials furnished by the Contractor, will be allowed unless ordered in writing by the Board of Trustees, and all claims for damages, for any cause whatsoever, must be reported to the Inspector on the work at the time that such damages occur, and such claims must be presented to the Engineer in charge of the work at the end of the same month, by the Contractor; otherwise the Village will not be bound to pay any such claims.

Monthly estimates will be made by the Board of Trustees of the value of the work actually constructed and in its permanent place; and vouchers for ninety (90) per cent. of the estimated value of the work done the previous month

will be issued, the remaining ten (10) per cent. to be reserved until the completion and acceptance of the whole work.

All work included in this contract is to be completed on or before ______________________________

The actual length of each sewer to be built may be more or less than the corresponding length given in the plans and the Specifications but no variation will be made in the rates on that account.

No claim for an amount of money beyond the contract price of the work will be entertained or allowed on account of the character of the ground in which the trench or other excavations are made.

Anything omitted in these Specifications necessary to fully complete the sewers in workmanlike manner shall be done by the Contractor without cost to the Village.

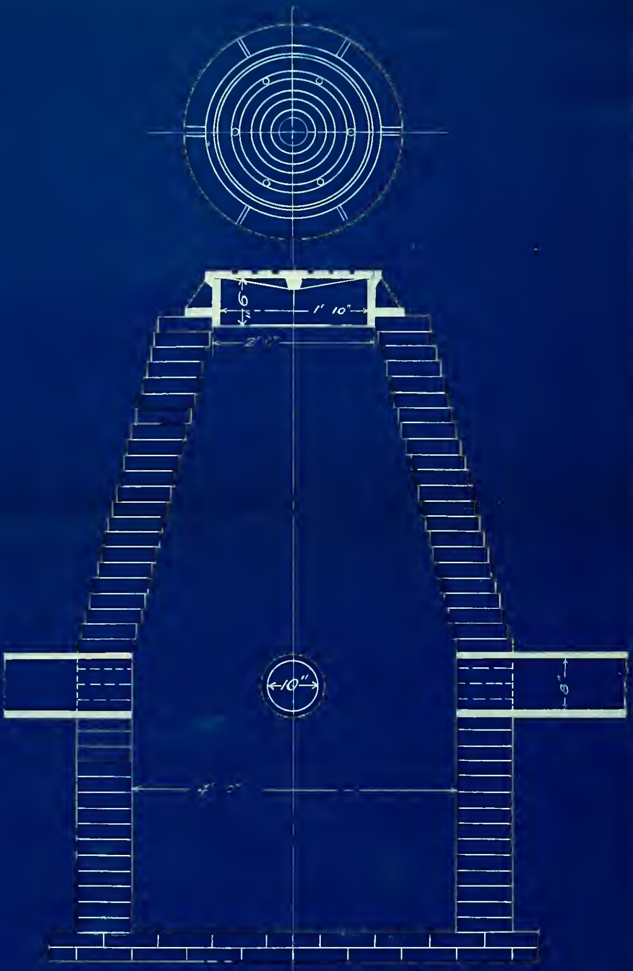
The undersigned hereby certify that they have read the foregoing specifications, and that the proposal for the work is based on the conditions and requirements embodied therein, and should the contract be awarded to him or them, he or they agree to execute the work in strict accordance herewith.

NAME ______________________________

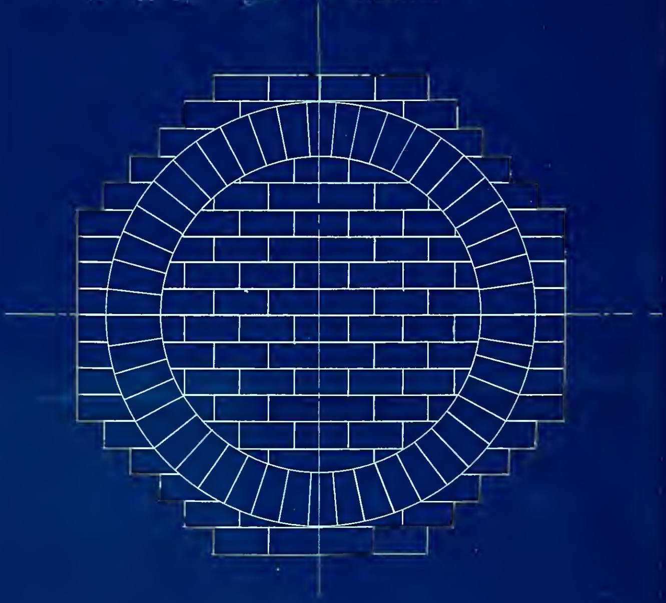
RESIDENCE ______________________________

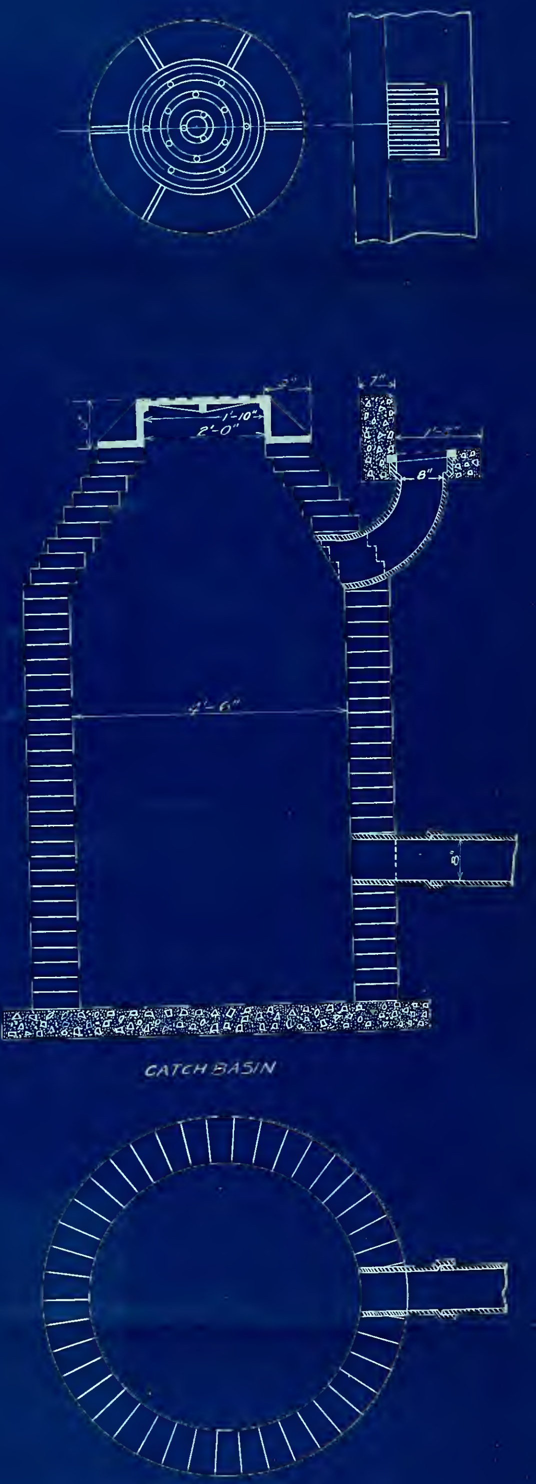
NAME ______________________________

RESIDENCE ______________________________



CATCH BASIN
STORM SEWER





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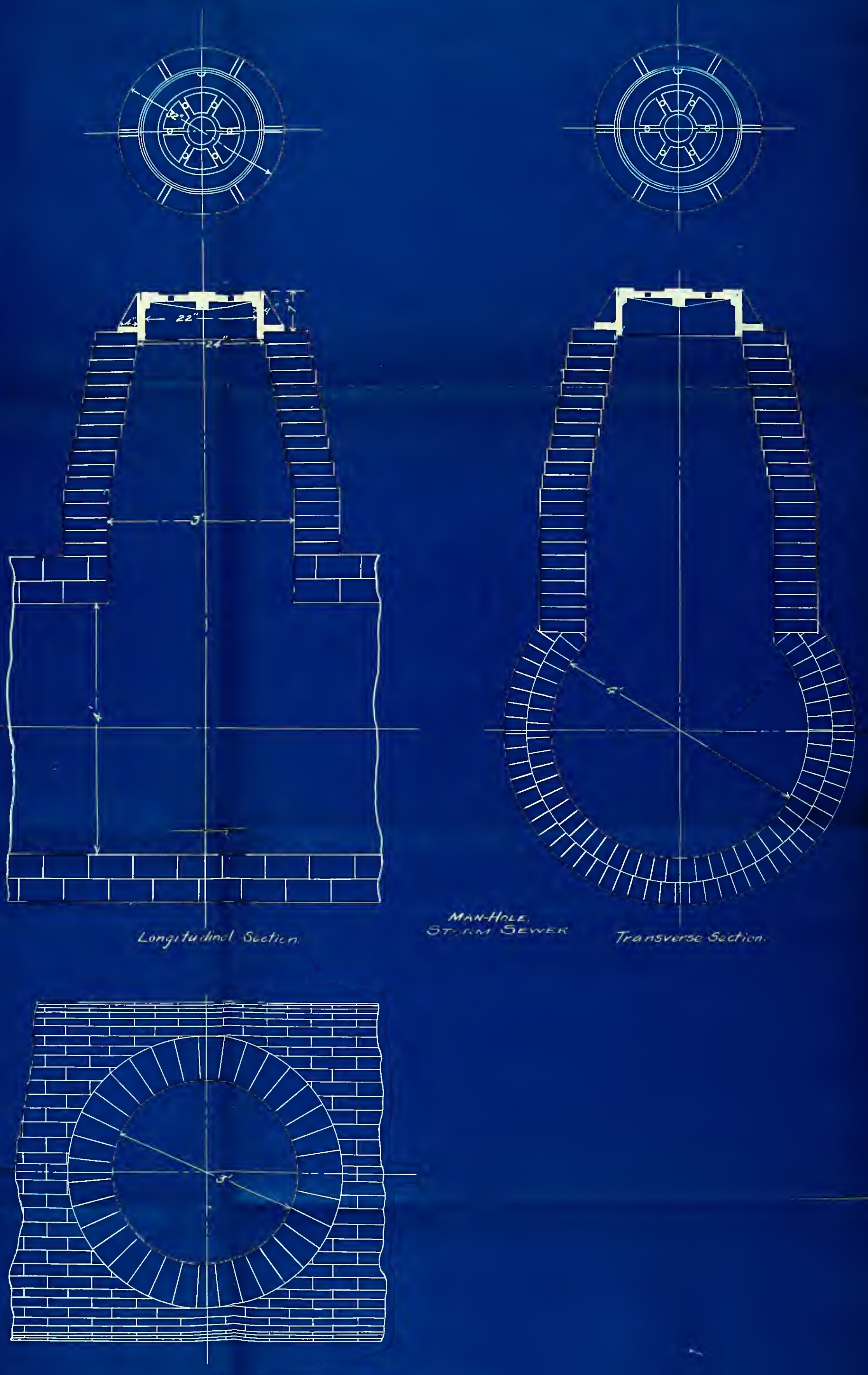
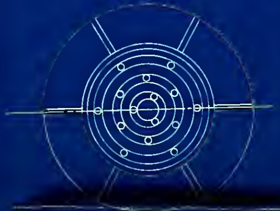
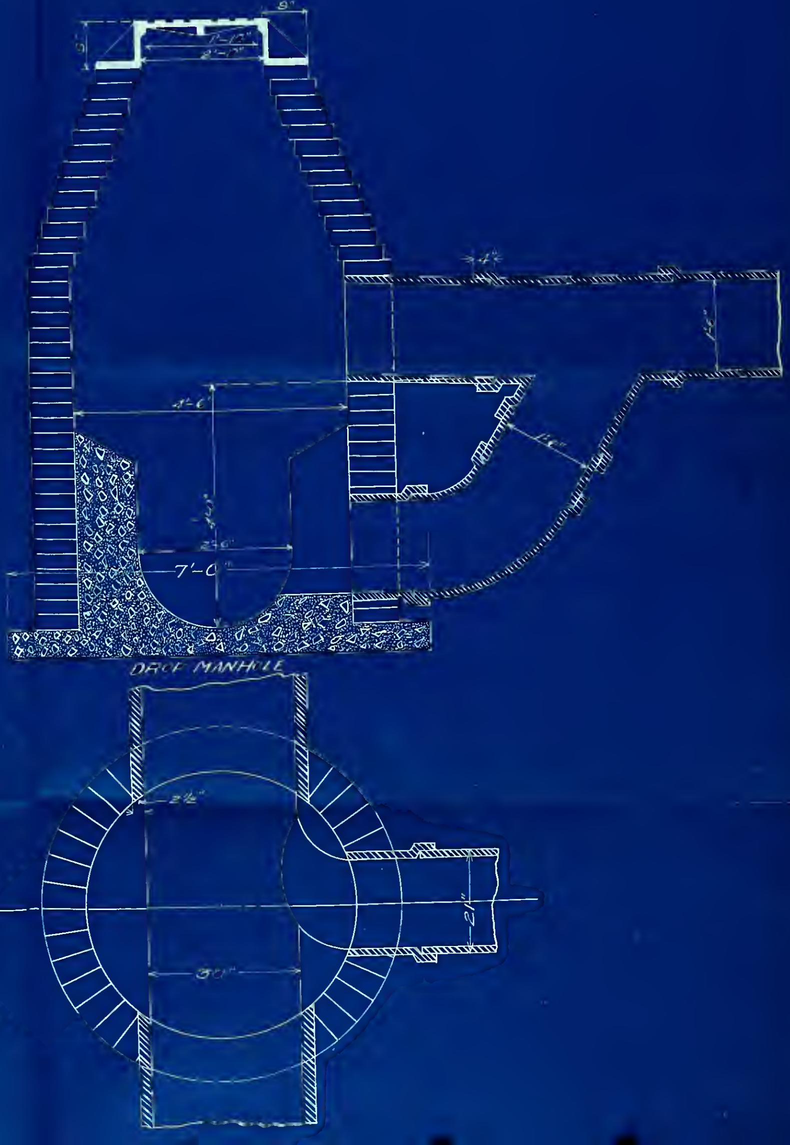


MAN-HOLE.
STORM SEWER

STANDARD MANHOLE
COVER



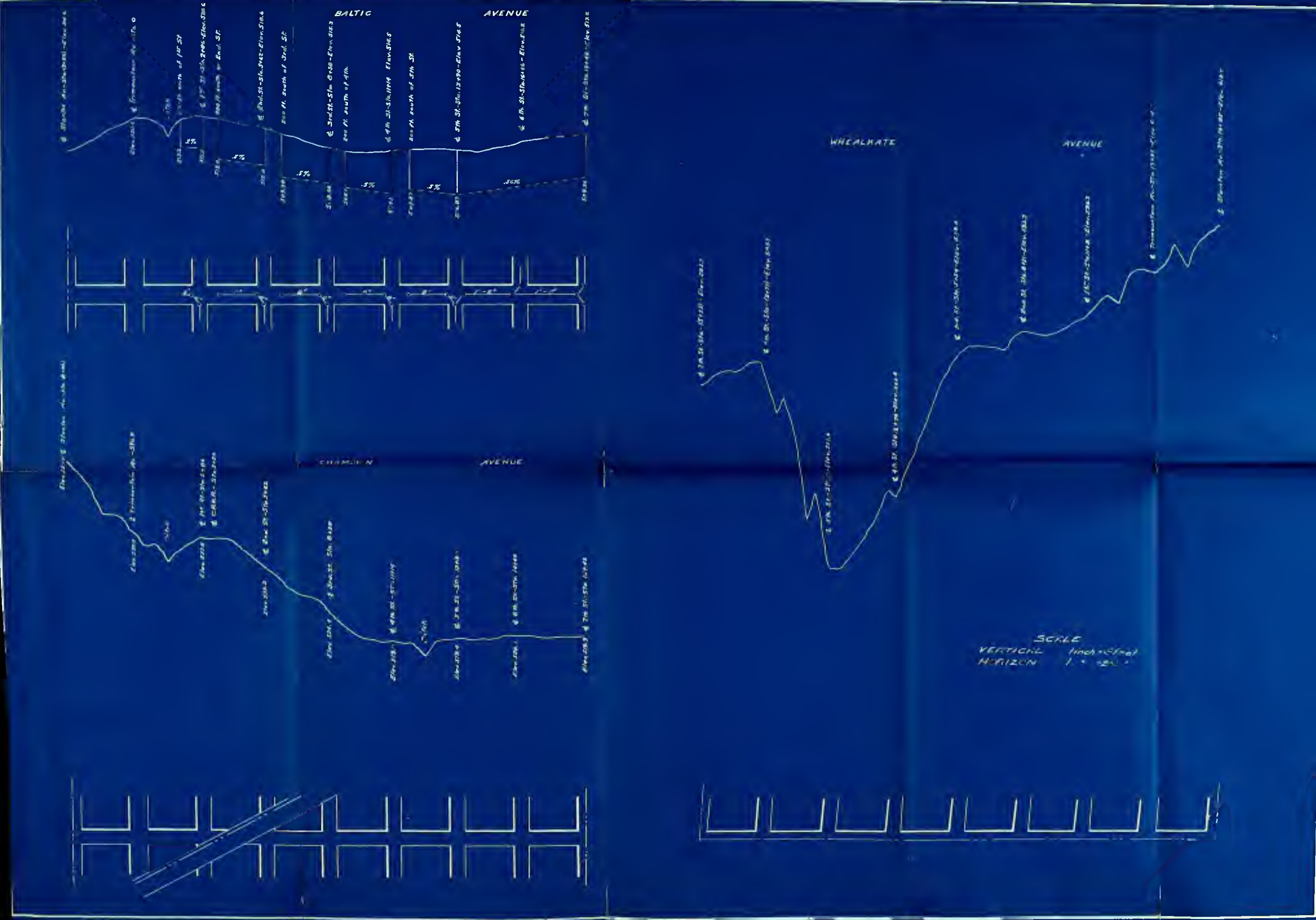


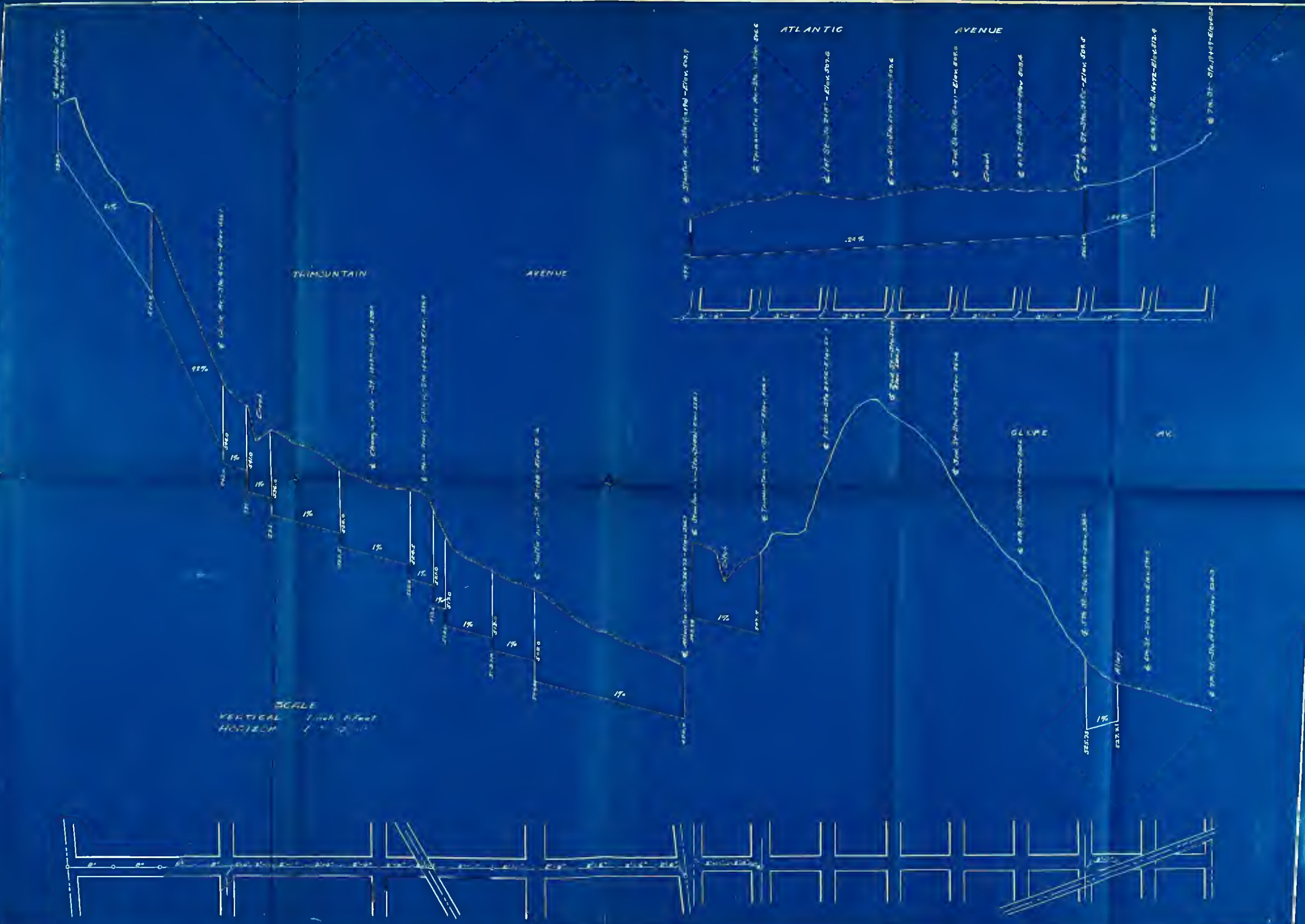
DROP MANHOLE

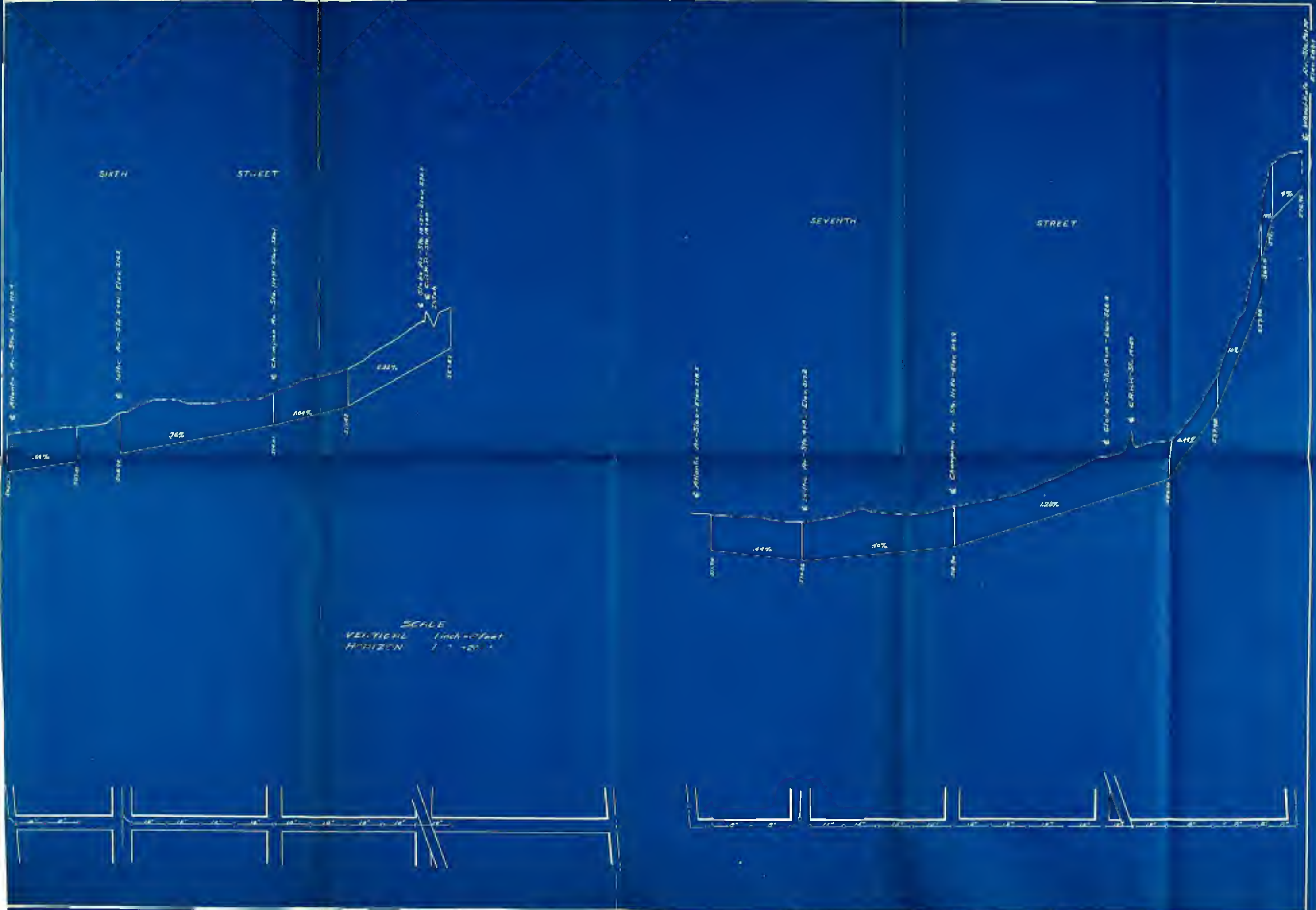
TABLE

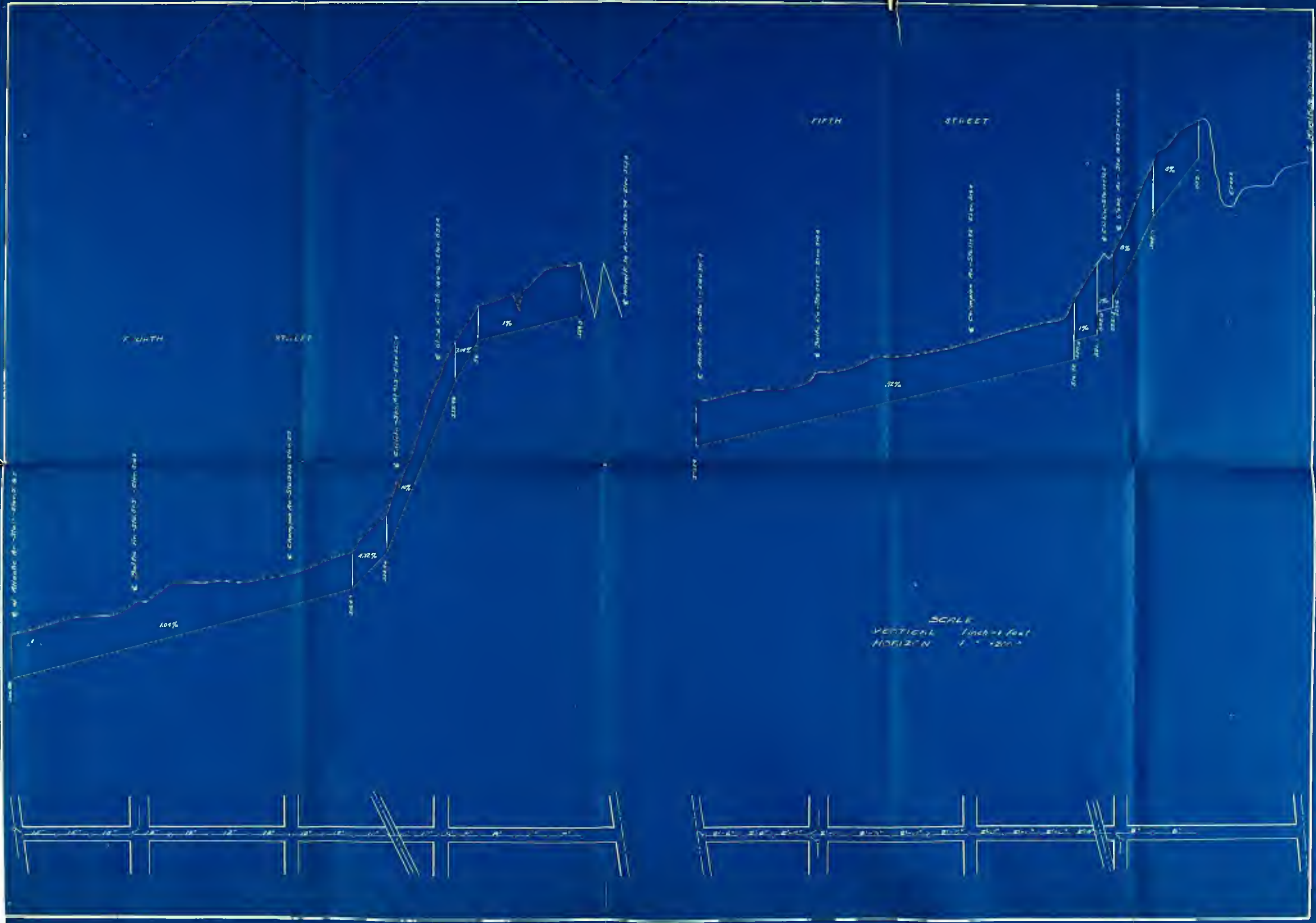
SHOWING DISCHARGE, VELOCITY & SIZE OF PROPOSED SEWERS IN SOUTH RANGE MICH.

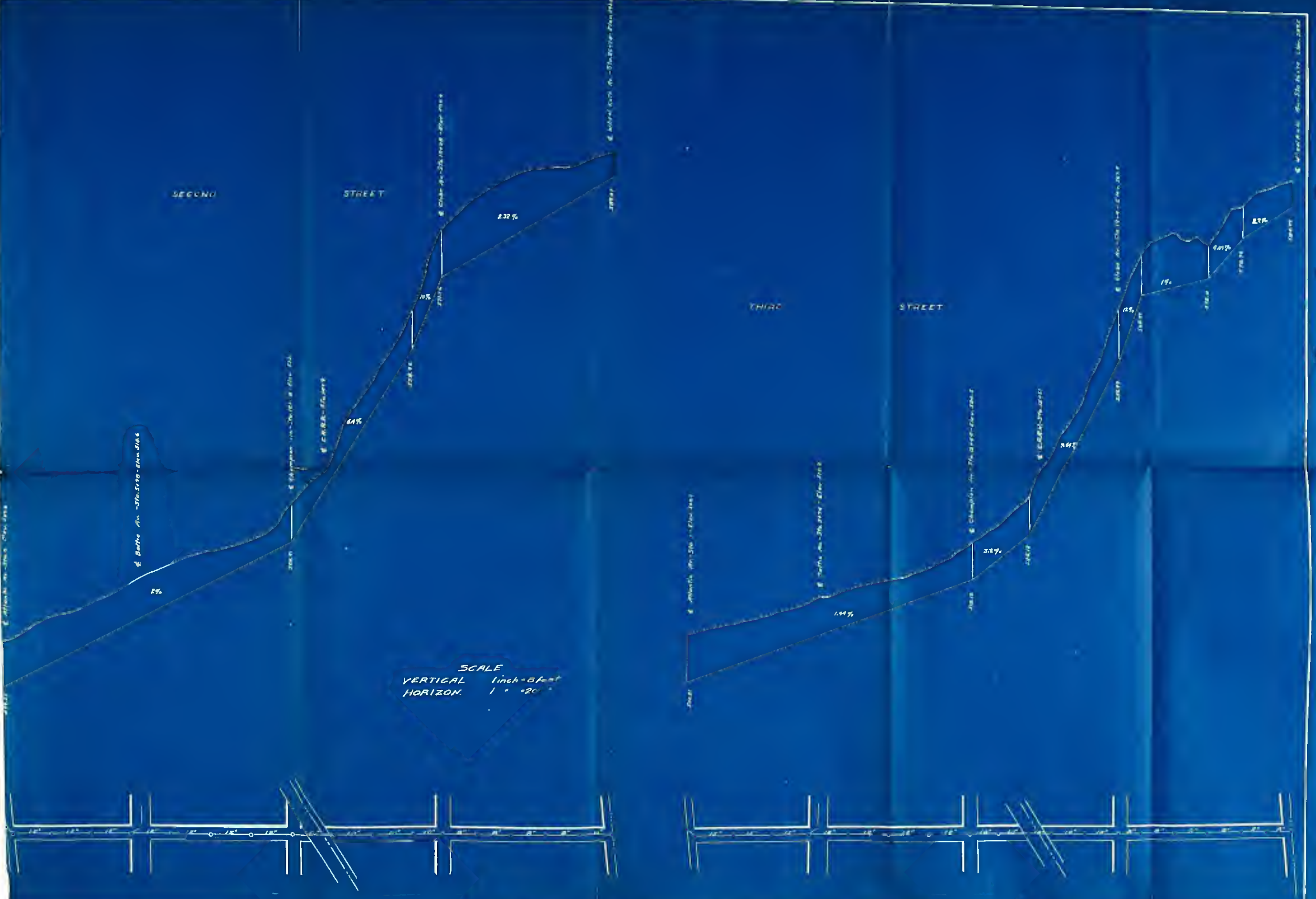
Location	Discharge	Velocity	Diameter
Stanton Ave — From Wheelkate to 145 feet west of Globe Ave	.34	7.92	8"
Stanton Ave — From 145 feet west of Globe Ave to Globe Ave	20.54	6.01	2'-0"
Stanton Ave — From 531 feet west of Champion to 527 feet west of Baltic	.35	4.60	8"
Stanton Ave — From 527 feet west of Baltic to 177 feet west of Baltic Ave	.53	8.55	10"
Stanton Ave — From 177 feet west of Baltic to Atlantic Ave	.83	4.48	12"
Trimountain Ave — From Wheelkate Ave to Globe Ave	.51	7.67	8"
Trimountain Ave — From Globe Ave to Baltic Ave	21.99	6.01	2'-0"
Trimountain Ave — From Baltic Ave to Atlantic Ave	22.40	7.07	2'-6"
First St — From Wheelkate Ave to Globe Ave	.40	5.62	8"
First St — From Globe Ave to Champion Ave	.85	5.80	10"
First St. — From Champion Ave. to Baltic Ave	1.33	6.21	12"
First St — From Baltic Ave to Atlantic Ave	1.74	6.31	15"
Second St — From Wheelkate Ave to Globe Ave	.40	3.63	8"
Second St — From Globe Ave to Champion Ave	.85	7.63	10"
Second St — From Champion Av. to Baltic Ave.	1.33	5.00	12"
Second St. — From Baltic Ave. to Atlantic Ave.	1.74	5.93	15"
Third St — From Wheelkate Ave. to Globe Ave.	.52	2.56	8"
Third St — From Globe Ave to Champion Ave.	.97	5.49	10"
Third St — From Champion Ave. to Baltic Ave	1.45	4.25	12"
Third St — From Baltic Ave to Atlantic Ave	1.82	5.05	15"
Fourth St — From 623 feet west of Globe to Globe Ave	.42	2.56	8"
Fourth St — From Globe to 281 feet west of Champion Ave	.94	6.41	10"
Fourth St — From 281 feet west of Champion to Baltic Ave.	1.61	4.25	12"
Fourth St — From Baltic Ave. to Atlantic Ave.	1.98	5.05	15"
Fifth St — From 330 feet west of Globe to Globe Ave.	.22	5.62	8"
Fifth St — From Globe Ave to Baltic Ave	14.01	5.77	2'-0"
Sixth St — From 118 feet west of Globe to Champion Ave	.52	3.05	10"
Sixth St — From Champion Ave to Baltic Ave	.92	3.13	12"
Sixth St — From 360 feet west of Atlantic to Atlantic Ave	.25	2.04	8"
Seventh St — From Wheelkate to 230 feet west of Globe Ave.	.39	6.56	8"
Seventh St — From 230 feet west of Globe to Champion Ave	1.03	3.53	12"
Seventh St — From Champion to Baltic Ave	1.42	2.52	15"
Seventh St — From Baltic Ave to Atlantic Ave	.26	1.79	8"
Baltic Ave — From Seventh St to Fifth St	1.96	3.04	1'-6"
Atlantic Ave — From Sixth St to Fifth St	.50	3.66	10"
Atlantic Ave — From Fifth St to Third St	20.15	4.04	3'-0"
Atlantic Ave — From Third St to Stanton Ave	40.30	4.51	3'-6"

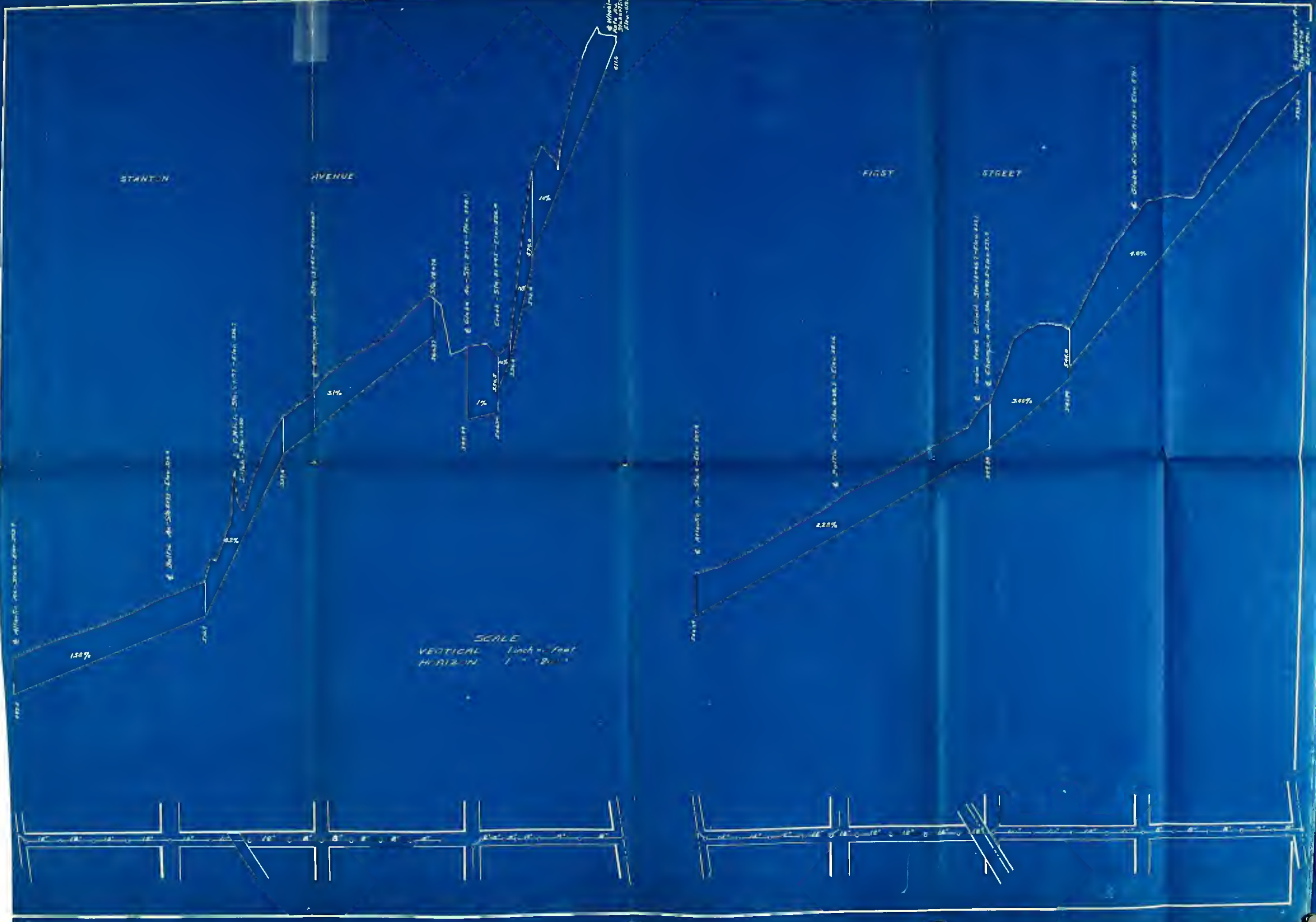

BALTIC AVENUE
WHEALKATE AVENUE
CHAMOUNIX AVENUE
SCALE
VERTICAL 1 inch = 5 feet
HORIZON 1 " = 200 "

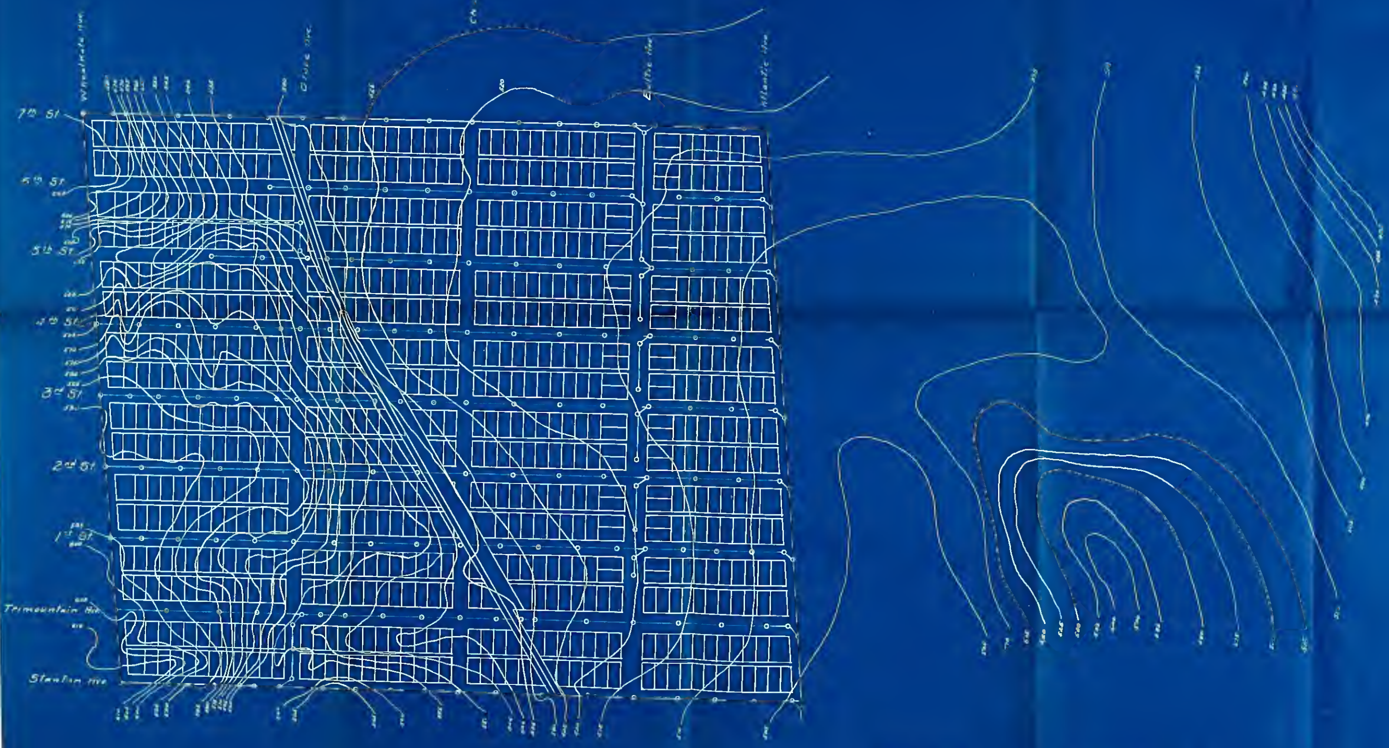

ATLANTIC AVENUE
TRIMOUNTAIN AVENUE
GLOBE AV.
Elev. 503.9
Elev. 507.8
Elev. 508.5
Elev. 512.4
.24 %
9.2%
1%
Grade
Alley
SCALE
VERTICAL 1 inch 8 Feet
HORIZON 1 "


SIXTH STREET
.61%
.76%
1.04%
2.32%
SEVENTH STREET
.44%
.40%
1.28%
6.44%
10%
4%
SCALE
VERTICAL 1 inch = 2 feet
HORIZON 1 " = 20 "


FOURTH STREET
FIFTH STREET
1.04%
4.32%
10%
7.04%
1%
.32%
1%
8%
5%
SCALE
VERTICAL 1 inch = 4 feet
HORIZON 1 " = 200 "


SECOND STREET
2%
6.1%
10%
2.32%
THIRD STREET
1.44%
3.2%
12%
1%
4.01%
2.3%
SCALE
VERTICAL 1 inch = 6 feet
HORIZON. 1 " = 20 "


STANTON
AVENUE
FIRST
STREET
1.50%
6.2%
3.1%
1%
10%
10%
2.28%
3.46%
4.8%
SCALE
VERTICAL 1 inch = feet
HORIZON 1 " 20 "



Topographic Map of Village of
– South Range –

Scale 1 inch = 200 feet.
1-18-1910.

E. J. Ekman